Benefits Assessments / Information

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460
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OFFICE OF
PREVENTION, PESTICIDES
AND
TOXIC SUBSTANCES

Memorandum

DATE:

SUBJECT: Biological and economic assessment for carbaryl use on grapes: Impacts from changes in the re-entry interval

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PEER REVIEW DATE: May 28, 2003

SUMMARY

Use of carbaryl on grapes has raised health risk concerns for farm workers entering vineyards following

an application. The re-entry interval (REI) that would reduce exposure to levels at or below concern is 10 to 14 days, depending on the crop production activities, including thinning, leaf pulling and vine tying/training. Most grape production systems, whether wine, table, or juice varieties, require these activities at various times during the season. The length of the proposed REI will make use of carbaryl impractical, especially for wine and table grapes, and growers will be forced to use alternative pest control measures. The longest REI that these growers are likely to accept before shifting to another insecticide is 48 hours.

Carbaryl is used mainly on grapes east of the Rocky Mountains for control of the grape berry moth and the grape leaf roller. It is a broad-spectrum insecticide that also controls a number of secondary pests. Carbaryl is applied to about 60% of the bearing acres in the South and Northeast, but to only 1 or 2% of grape acres in California and the Pacific Northwest. The most likely alternative to carbaryl is fenpropathrin, a broad-spectrum pyrethroid, that is slightly more costly. It is also less convenient to use because it is a restricted use pesticide and requires a 21-day interval between use and harvest so that it cannot be used late in the growing season. It could also depress populations of predatory mites and lead to outbreaks of spider mites. However, use of fenpropathrin to replace carbaryl is not expected to result in yield or quality losses.

Losses due to higher production costs may be around $5.00 per acre per application. This represents around 1 or 2% of net cash returns to wine grape producers, but information is not available to determine relative impacts on producers of juice grapes. About 39,700 acres of grapes are treated with carbaryl in the Northeast and South, with an average of two applications each year. Simply multiplying the per-acre losses by the treatments implies total losses to the region of around $397,000 each year. This is about 0.4% of the gross value of production for the two regions. Small losses should also be anticipated in California and the Pacific Northwest. Based on these considerations, BEAD concludes that extending the REIs for carbaryl use should cause a negligible impact on grape production.

LIMITATIONS AND SCOPE OF ANALYSIS

The scope of this analysis comprises an examination of potential per-acre and regional-level impacts associated with extension of the re-entry interval (REI) for activities that follow application of carbaryl in grapes. This mitigation scenario reflects the health risks to farm workers as identified by the Health Effects Division of the Office of Pesticide Programs. This analysis does not attempt to address impacts associated with mitigation efforts targeted at mixers, loaders and applicators of carbaryl or potential mitigation for various other environmental risks (*e.g.*, risk mitigation for risks to non-target organisms).

The impacts estimated by this analysis only represent potential short-term impacts, *i.e.*, one to five years, on the grapes production systems and grower returns. Assumptions such as what pesticide alternatives will be available, can not be made reliably beyond this period. Impacts to the industry are calculated by simply scaling up the estimated per-acre impacts. We ignore potential price changes that could result from production changes and grower impacts assume that there is no shift from grapes to another crop. Estimates of yield and quality losses associated with the various scenarios are based on the best

professional judgement of BEAD analysts when they were not available from other sources. These estimates were derived from reviewing available USDA crop profiles, state crop production guides, discussions with university extension and research entomologists knowledgeable in grape production, and other sources listed. Grape production is a complex system that can be influenced by a variety of parameters (*e.g.*, weather). BEAD's ability to quantitatively capture the wide array of events that could unfold given each hypothetical scenario listed above is very limited.

CROP PRODUCTION

California is by far the largest producer of grapes in the U.S. with about 825,000 bearing acres in 2002, out of about 935,000 acres nationally (USDA/NASS, 2002). Acreage in most states is expanding. Between 1999 and 2002, U.S. production averaged over 6.9 million tons of grapes annually. California production accounts for over 90%. Gross value of production has averaged $2.9 billion between 1999 and 2002. Table 1 provides acreage production and value figures for selected states and regions.

Table 1. Average acreage, production and value, 1999-2002.

State/Region	Bearing Acreage	Production (tons)	% of Total Production	Value ($1000)	Price ($/ton)
California	811,300	6,270,000	90.8%	2,698,827	430
Arizona	3,450	16,200	0.2%	12,057	744
Pacific NW[1]	54,200	306,800	4.4%	156,514	510
Northeast[2]	58,400	297,400	4.3%	85,092	286
South[3]	6,600	17,700	0.3%	15,733	889
U.S.	933,900	6,908,100		2,968,224	430

Source: USDA/NASS, *Noncitrus Fruits and Nuts, various years*

[1] Oregon and Washington.

[2] Michigan, New York, Ohio and Pennsylvania.

[3] Arkansas, Georgia, Missouri, North Carolina, South Carolina, Texas and Virginia.

Certain grape varieties are targeted toward specific markets, including table grapes, grapes for raisins and wine grapes. However, actual utilization is somewhat flexible, particularly within table grape varieties. According to USDA/NASS (various years), over half of California production is for wine, including about 15-20% of the table and raisin grapes varieties. About 25% of total production is dried for raisins; in California, almost 70% of raisin varieties and about 4% of table grapes are dried. About 13% of total production goes to the fresh market, including about 80% of the table grapes and 10% of the raisin varieties in California. Arizona and Georgia are the other main states where table grapes are dominant. The production region around the Great Lakes, including New York, Michigan and Pennsylvania, and the Pacific Northwest primarily focus on juice production with some wine. Nationally, about 7% of production

is for juice or other uses, but makes up almost 70% of the production outside California. Table 2 provides summary data on utilization of production.

Table 2. Utilization of production by state, 1999-2002, in tons.

State/Region	Table/Fresh (%)	Wine (%)	Raisin (%)	Juice & Other (%)	Total Production
California	882,800 (14.1%)	3,560,800 (56.8%)	1,794,800 (28.6%)	31,800 (0.5%)	6,270,000
Arizona	10,400 (63.9%)		5,600 (34.4%)		16,200
Pacific NW[1]		114,300 (37.3%)		192,500 (62.7%)	306,800
Northeast[2]	3,400 (1.1%)	59,800 (20.1%)		234,200 (78.8%)	297,400
South[3]	2,400 (13.6%)	13,800 (78.0%)		1,700 (9.6%)	17,700
U.S.	899,000 (13.0%)	3,748,600 (54.3%)	1,800,300 (26.1%)	460,200 (6.7%)	6,908,100
U.S. excluding CA	16,200 (2.5%)	187,900 (29.4%)	5,600 (0.9%)	428,400 (67.1%)	638,100

Source: USDA/NASS, *Noncitrus Fruits and Nuts, various years*. Figures may not sum to 100% due to rounding.

[1] Oregon and Washington.

[2] Michigan, New York, Ohio and Pennsylvania.

[3] Arkansas, Georgia, Missouri, North Carolina, South Carolina, Texas and Virginia.

CARBARYL USAGE ON GRAPES

BEAD (2002) estimated that carbaryl use on grapes totaled about 134,000 active ingredient (a.i.) annually, between 1992 and 2001. An estimated 58,000 acres were treated each year, representing about 6.8% of the acreage. The most recent USDA reports (2000, 2002) indicate that about 84,400 lb a.i. are used annually to treat approximately 41,300 acres. These data are from only selected states and may underestimate total usage. The total acres devoted to grapes has increased in recent years, from an average of 851,000 acres over the ten year period to about 1,050,000 in 2001. Carbaryl is used on only about 4% of current acreage in states surveyed.

This low use rate masks some important regional differences in carbaryl use. Over 90% of grape bearing acreage is found in California, but the most recent USDA and California Department of Pesticide Regulation data indicate that only 1.2% of the area is treated with carbaryl. Similarly, only 2.2% of the grape acreage in the Pacific Northwest are treated. However, east of the Rocky Mountains, usage is much greater. Grape producers in the Northeast and South treat about 60% of their acreage, often multiple times. NASS (2000, 2002) report between 60 and 70% of acreage is treated in Michigan, New York and Pennsylvania. According to available USDA crop profiles, carbaryl is applied to 40% of the acreage in Missouri, 90% of the acreage in Ohio, Virginia, and North Carolina; and up to 100% of the grape acreage in Indiana and Tennessee. Table 3 presents BEAD estimates of total usage, extrapolating from reporting states to the regional level. This indicates about 35,700 acres are treated with about 100,000 lb a.i. in the Northeast, compared to less than 10,000 acres in California treated with 18,000 lb a.i. Southern states, with less than 1% of the acreage of California, still use almost two-thirds the amount of carbaryl.

Table 3. Carbaryl usage on grapes, 1999 and 2001, extrapolated from reporting states.

	Acreage	Area Treated	% Crop Treated	lb a.i. Applied	Rate (lb/acre/year)
California	811,300	9,700	1.2	18,430	1.90
Arizona	3,450	70	1.9	140	2.00
Pacific NW[1]	54,200	1,190	2.2	1,610	1.35
Northeast[2]	58,400	35,740	61.2	100,070	2.80
South[3]	6,600	4,000	60.6	11,600	2.90
U.S.	933,900	50,700	5.4	131,850	2.60

Source: USDA/NASS, 2000, 2002, California DPR, 2002, EPA data. Totals may not sum due to rounding.

[1] Oregon and Washington.

[2] Michigan, New York, Ohio and Pennsylvania.

[3] Arkansas, Georgia, Missouri, North Carolina, South Carolina, Texas and Virginia.

According to EPA data, the vast majority of applications are made during the period between bloom and harvest. Data indicate that, in the Northeast, an important number of applications are also made between bud break and bloom. Only about 2% of the treated acres are treated following harvest or during the dormant season. One to four applications may be made with an average of two. These data probably apply equally to the South.

TARGET PESTS

Current carbaryl labels for grapes allow a maximum application rate of 2 lb a.i./acre and up to five applications per season. Nationwide, carbaryl is applied to this crop, on average, once or twice per year, at a rate of 1 to 2 lb a.i./acre/application. Available carbaryl formulations include aqueous dispersion, baits,

dusts, emulsifiable concentrates, flowables, granules, soluble concentrates, suspension concentrates, wettable powders, and water dispensable granules.

In wine producing states east of the Rockies, carbaryl is an important component of current pest management practices. In those states, carbaryl is used mainly to control the grape berry moth (*Endopiza viteana*) and grape leafhopper (*Erythroneura comes*), both of which are key pests of grapes, capable of inflicting severe damage to the crop if not controlled. In abandoned vineyards, up to 90% of the fruit can be destroyed by larval feeding activities, as well as by diseases, as feeding damage facilitates the invasion of pathogens (USDA, 1999d). Pheromone traps and scouting are used to monitor moth populations and time pesticide chemical applications. The USDA Crop Profile for Ohio Grapes, for instance, recommends chemical treatment if cluster damage reaches 6% in grapes grown for processing or 3% in grapes grown for fresh market.

East of the Rockies carbaryl is also used to control numerous minor pests, such as the banded grape bug (*Tydia scrupea*), potato leafhopper (*Empoasca fabae*), grape flea beetle (*Altica chalybea*), grape rootworm (*Fidia viticida*), Japanese beetle (*Popillia japonica*), green June beetles (*Cotinis nitida*), rose chaffer (*Macrodactylus subspinosus*), several climbing cutworm species, European corn borer (*Ostrinia nubilalis*), and yellow jackets and other wasps. The Japanese beetle, a voracious foliage feeder, is of some concern. Although damage to grapes is reported to be mostly cosmetic in growing vines, excessive foliar feeding in newly planted vineyards can result in delayed root and canopy development resulting in a delay of one year or more in terms of full crop production (USDA, 2000b, 2002b). As a rule, applications intended to control the two primary pests also control secondary pests.

Unlike the eastern states, carbaryl plays a minor role in grape pest management in western states. In California carbaryl is applied to table and raisin grapes primarily for late season leafhopper control, at a rate of up to 2.0 lb a.i./acre (USDA, 1999a). Comments submitted by Western Region Pest Management Center Director, Rick Melnicoe, indicate that in 2001 the median application rate was 1.0 lb a.i./acre on table grapes and 1.6 lb a.i./acre on wine grapes. Carbaryl has also been used occasionally in California to control the omnivorous leafroller (*Platynota sultana*), western grape-leaf skeletonizer (*Harrisina brillians*), the grape leaf folder (*Desmia funeralis*), and the false chinch bug (*Nysius raphanus*). In California carbaryl is considered to be disruptive to mite's natural enemies and newer chemistries, such as fenpropathrin, are preferred (USDA, 2002c).

In the grape-producing states east of the Rockies, carbaryl is generally preferred to its alternatives because: a) It has broad-spectrum activity, being effective against key and secondary grape pests. b) It does not tend to flare spider mites by killing predatory mites as is the case with methomyl and fenpropathrin. c) It has long-lasting residual effect. d) Currently, it is not a restricted use pesticide (RUP), while its leading alternatives fenpropathrin, methomyl, and azinphos methyl are RUPs. e) Its use is economical.

ALTERNATIVE CONTROL METHODS

Available insecticide alternatives for use against the two main carbaryl target pests, the grape berry moth

and leafhoppers, are: fenpropathrin, methomyl, azinphos-methyl, phosmet, *Bacillus thuringiensis* (Bt), and Isomate GBM pheromone ties used to disrupt mating.

Fenpropathrin is a broad-spectrum pyrethroid insecticide that provides effective control of most carbaryl major and minor target pests (English-Loeb, personal comm.; Isaacs, comm. to A. Britten). However, because this alternative is both a pyrethroid and a good miticide, there is concern that its increased use could also lead to spider mite problems by fostering the development of resistance and eliminating predatory mites that keep spider mite populations in check. Furthermore, relying on a single pyrethroid insecticide may eventually hasten the development of resistance in the grape berry moth.

Methomyl is a broad-spectrum carbamate insecticide labeled for control of leafhoppers, grape berry moth, leafrollers, leaffolders, and other lepidopteran grape pests. However, methomyl is seldom used on grapes, mainly because of its high acute mammalian toxicity, its relatively low residual activity, and its tendency to cause spider mite outbreaks (English-Loeb, personal comm.).

Phosmet is a non restricted-use OP insecticide that can be used to control the grape berry moth and most minor pests. However, it has only limited effectiveness on leafhoppers (English-Loeb & Weigle, letter to W. Smith, 2003).

Azinphos-methyl, another OP is slated to be phased-out for use in grapes in the near future and cannot be considered as a carbaryl alternative.

Mating disruption using pheromone ties, in addition to being expensive, is only marginally effective in controlling the grape berry moth (MSU, 2002). This technique is best suited for situations where moth populations are low and cannot be considered as an alternative for carbaryl.

Bt is a selective insecticide (effective against lepidopterous pests) that must be applied twice per generation for control of the grape berry moth. However, the two Bt applications do not provide as good control as a single carbaryl application (G. English-Loeb & T. Weigle, written comm. to W. Smith, 2003).

Three recently registered insecticides for grape pest control are methoxyfenozide, spinosad, and imidacloprid. Although these insecticides are rather selective and more expensive than carbaryl, grape growers east of the Rockies could use them when necessary. Methoxyfenozide and Spinosad are labeled for control of the grape berry moth and minor lepidopterous pests, but not for use against leafhoppers. Imidacloprid controls leafhoppers and mealybugs, but not the grape berry moth. None of these chemicals, by themselves, could replace carbaryl on a one to one basis.

Insecticides labeled for Japanese beetle control on grapes include fenpropathrin, phosmet, malathion, methoxychlor, pyridaben, and endosulfan. Alternatives available for control of leafhoppers on grapes include pyridaben and methoxyfenozide.

BIOLOGICAL IMPACT OF CARBARYL CANCELLATION FOR GRAPES

EPA is proposing to increase the current REI for carbaryl on grapes from 12 hours to 10 days for high exposure activities (hand-harvest, leaf-pulling, thinning, pruning, and training/tying) and to 14 days for very high exposure activities (girdling, cane turning). East of the Rockies, carbaryl is applied at bloom time to control first generation grape berry moths, leafhoppers, and the rose chaffer. Later in the season, control of the berry moth coincides with the need to control the Japanese beetle and late-season leafhopper populations (Isaacs, comm. to A. Britten). The proposed REI increase would interfere with several key activities which are often performed on a daily basis during the time when carbaryl is used. This is especially true for grapes grown for wine. Growers and workers need to enter their vineyards for thinning, leaf-pulling, shoot positioning/tucking, and other manual canopy adjustments. Under this scenario, 48 hours would be a more acceptable REI for grape growers (R. Isaacs, written comm. to A. Britten, 2003). Thinning in the east is mainly, although not exclusively, done mechanically, using modified harvesters. Leaf pulling to open up the fruit zone for better circulation, disease reduction, and improved spray coverage is often done with a machine pulled by a tractor. Although in these cases there is no direct contact with the foliage, the tractors lack cabs or have cabs lacking filtration systems required as substitute for personal protective equipment (PPE). Scouting for pests, although also common during this time, is an REI exempt activity. As there is very little pesticide application close to the harvest season, the extended REI for hand-harvest activities is not expected to affect grape production practices (English-Loeb, personal comm.; Isaacs, comm. to A. Britten).

In BEAD's opinion implementation of the proposed, longer (REIs), would make carbaryl use impractical for most growers, amounting to a *de facto* cancellation of this chemical. Only very minor usage during the post-harvest and dormant periods could continue. In place of most applications of carbaryl, growers would be forced to shift to the next best available insecticide, fenpropathrin, which is considered by crop specialists to be similar to carbaryl in effectiveness against carbaryl's primary and secondary target pests. BEAD does not anticipate that shifting to fenpropathrin and other alternatives will result in an increased loss of yield or quality to the grape industry.

ECONOMIC IMPACT OF CARBARYL CANCELLATION FOR GRAPES

Per-acre Impacts

BEAD used a partial budget approach to analyze the short-term impacts on grape producers of a switch from carbaryl to fenpropathrin for control of grape berry moth and leaf hopper. Crop budgets from Iowa (Domoto, 2001), Ohio (Brown and Moore, 2003, and Ohio State University Extension, 2001) and New York (White and Pisoni, 2001) were examined and the New York budget was chosen as most representative of the major producing areas of New York, Pennsylvania and Michigan and because it was the most detailed.

The principal disadvantage of these budgets is that they detail production costs of wine grapes (Iowa, Ohio and New York) or table grapes (Ohio). Production for juice accounts for almost 80% of grapes in the region, while table grapes make up only about 1% of production and wine approximately 20%. Wine and table grapes command significantly higher prices. The New York budget suggests prices of around

$1,400/ton while NASS statistics indicate the average price of grapes in New York is about $370/ton. Juice grapes probably yield more; White and Pisoni estimate about 3.0 tons/acre of wine grapes while the average yield for all grapes in New York is about 4.6 tons/acre. This suggests very different production costs, with wine grapes likely to entail much higher inputs.

Table 4 presents estimates of gross revenues, production costs and net returns for wine grapes in New York. Gross revenues are calculated to be around $4,200/acre. Production costs for wine grapes total around $1,980/acre, about half of which are labor costs. Insecticides make up a small proportion of production costs; carbaryl is the only insecticide mentioned in the budget. Fungicides make up most of the pesticide costs. According to BEAD data, an average application of carbaryl costs $8.38/acre while fenpropathrin costs $13.36/acre, an increase of almost 60%. However, this represents an increase in operating costs, including harvest costs, of only 0.2%. Since a vineyard requires significant establishment costs, covering three years before production begins, we include repayment, $1,475/acre, of that investment in this budget. Repayment was calculated using an annual interest of 8% with a pay period of 10 years. Investment costs over three years total approximately $9,900 (White and Pisoni, 2001). This leaves about $566/acre as the returns to land and the owner's management skills. The additional cost of fenpropathrin reduces net cash returns by about $5.00/acre or 0.9%. If two applications of carbaryl are used, as occurs about 40% of the time in New York (NASS, 2002), losses are nearly $10.00/acre or 1.8% of net cash returns.

Table 4. Gross returns, production costs and net cash returns to wine grape production with treatments for grape berry moth and leaf hoppers.

	Base Scenario carbaryl	Alternative fenpropathrin	% Change
production (tons/acre)	3.0	3.0	0.0
price ($/ton)	1,410.00	1,410.00	
gross revenue ($/acre)	4,230.00	4,230.00	0.0
carbaryl fenpropathrin	8.38	13.36	59.4
other pre-harvest costs	1,972.00	1,972.00	
harvest costs	200.00	200.00	
total operating costs	2,180.00	2,185.00	0.2
establishment costs [1]	1,475.00	1,475.00	
net cash returns ($/acre)	574.00	569.00	-0.9

Source: White and Pisoni, 2001; BEAD data.

All units are $/acre unless otherwise noted. Totals may differ from the sum of components due to rounding.

[1] Establishment costs total $9,900/acre (White and Pisoni, 2001). BEAD assumes an annual interest rate of 8% with the costs to be paid off over 10 years.

Gross revenues for juice grapes are substantially lower than for wine. Gross revenues calculated using average yields of 5.3 tons/acre and prices, $291/ton (NASS, various years), are about $1,540/acre. Production costs for juice varieties must be lower as well. Establishment costs may also be lower. Absolute losses due to a shift from carbaryl to fenpropathrin may be similar, but the loss as a percentage of net cash cannot be determined.

Data from Michigan and Pennsylvania suggest that the difference in cost between carbaryl and fenpropathrin is not as great. Therefore the impacts calculated from the New York data may form an upper bound as to the regional impacts, although some growers maybe forced to use even higher cost alternatives depending on their circumstances.

Regional Level Impacts

To calculate regional level impacts, we simply multiply the loss per-acre by the number of acres affected. From Table 3, we see that about 39,700 acres are currently treated with carbaryl in the Northeast and South. Data from NASS (2002) suggest that from one to four applications are made per year, with an average of two. At $5.00/acre per treatment, total costs of a shift to fenpropathrin by grape producers are

calculated to be around $397,000 per year. This represents about 0.4% of the gross value of grape production in the two regions.

CONCLUSION

Carbaryl is used on grapes primarily in the east of the U.S. for control of the grape berry moth and the grape leaf roller, but also provides control of a number of secondary pests. The proposed REI of 10 to 14 days will render carbaryl impractical for most grape producers except for small amounts used during the dormant season and post-harvest. The most likely alternative is fenpropathrin, a broad-spectrum pyrethroid. The main disadvantages of fenpropathrin are that it is a restricted use pesticide, making it less convenient to use, requires a 21-day interval between treatment and harvest, and may cause outbreaks of mites by killing predatory species. Fenpropathrin is slightly more expensive, but yields are not expected to be affected. Losses from higher production costs may be between $5 and $10 per acre and could represent from 1 to 2% of net cash revenues. Total losses, given the number of acres treated and multiple applications could be around $397,000 annually.

This analysis has ignored carbaryl use in California and other regions because usage is relatively minor. However, the length of the proposed REI will result in shifts to higher cost pest control measures, although these costs are likely to be minor.

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Memorandum

DATE: June 12, 2003

SUBJECT: Benefits assessment for carbaryl use in citrus: impact of extending the re-entry interval (REI)

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Reviewed by BEAD Peer Review Panel: May 28, 2003

Summary

Carbaryl has been identified as posing health risks for workers engaged in a number of post-application activities in treated fields. It has been proposed that the re-entry interval (REI) following an application of carbaryl (regardless of formulation) would be extended from the current 12 hours to 6 days for lower contact activities (irrigation, scouting, and pruning) and to 10 days for higher contact activities (pruning and thinning). This assessment considers the relevance and impact of the proposed mitigation of carbaryl risks to workers in citrus groves in California and Florida. The largest amount of carbaryl use in citrus occurs in these states, which also produce the majority of US citrus crops. Use in California mainly targets the California red scale and the cottony cushion scale, while in Florida the critical target is the *Diaprepes* root weevil. BEAD believes that an REI longer than 5 days will prevent hand harvesting from occurring, thereby resulting in an effective loss of carbaryl use in all citrus, since this crop flowers and the fruit mature throughout the year, and harvest can thus occur across more than half the growing season. BEAD assumes here that irrigation and scouting could continue to be carried out at intervals less than 5 days, to the extent that these activities are exempted by worker protection standard (WPS) regulations. BEAD believes that pruning, the other critical worker activity likely to occur in treated groves, could continue to occur at intervals up to 7 days. If use of carbaryl is effectively lost, BEAD believes that in the short term at least (approximately 3 years), the remaining insecticide alternatives, along with non-chemical controls, will control all the major target pests. However, because the potential for resistance development exists, the remaining chemical alternatives are likely to also lose their effectiveness in the longer term. Non-chemical controls (primarily natural enemies in California and cultural practices in Florida) alone often cannot control these pest. When this happens, BEAD believes orange growers in California will face losses of up to 46% in per acre gross revenues due to fruit quality losses, leading to significantly higher losses in per acre net revenues. In Florida, although estimates of losses due to weevil resistance are not available, they could be significant.

Scope and Limitations of the Assessment

This assessment investigates the importance of carbaryl for citrus production in the major growing regions of the US. It also considers the applicability and possible impact of risk mitigation measures aimed at reducing exposure faced by workers who enter carbaryl treated fields to perform irrigation, scouting, pruning, or hand harvesting. The assessment assumes that the main mitigation scenario to be considered is the extension of the re-entry interval (REI). However, where available, this document also provides information on typical and/or minimum effective rates of carbaryl usage per application, since modification of rates is another potential mitigation measure.

This mitigation scenario reflects the high health risks to workers as identified by the Health Effects Division of the Office of Pesticide Programs. The assessment is based on a review of available USDA crop profiles, state crop production guides, applied entomology journals, and discussions with entomologists knowledgeable in citrus production in California and Florida. Pest management and economic impacts are predicted for 2 scenarios: the **short term** impact (up to 3 years) if carbaryl use was lost, and the **longer term** impact (beyond 3 years) that BEAD believes are likely to occur beyond this approximate time frame. Each scenario is discussed separately for California and Florida, since

different pests are considered the critical targets for carbaryl in each state.

Role of Carbaryl in Citrus Production

California

Target Pests

The main targets of carbaryl use in this state are the California red scale, *Aonidiella aurantii*, and the cottony cushion scale, *Icerya purchasi* (USDA 2001b, Berger, personal communication). Carbaryl is also used to control other sporadic but potentially serious pests, including Fuller rose beetle, black scale, fruittree leafroller, amorbia caterpillars, and the western tussock moth. Of these, the Fuller rose beetle, *Asynonychus godmani*, is arguably the most serious, because Pacific Rim countries require fumigation of citrus shipments if even a single insect is detected, which is expensive and can damage the fruit (USDA 2001a).

Scale are sedentary insects, and for most of their life, are covered by a thick layer of waxy material as protection. They are capable of causing great destruction to fruit directly, either by encrusting them while feeding, or blemishing them with honeydew (their excreta), which in turn fosters the growth of sooty mold, a fungus (Grafton-Cardwell et al. 2002). Packing houses often cannot clean infested fruit, in which case they are downgraded from the fresh market to processing (juice). Uncontrolled scale damage to fruit can result in upto 48 % of the harvest being downgraded (Grafton-Cardwell 2001). High populations of both scale can also reduce tree vigor and yield since they feed on the nutrient-rich tree sap. The cottony cushion scale was, until recently, under effective control by the Vedalia beetle, *Rodolia cardinalis*. However, the recent registration of new insect growth regulators (IGRs), buprofezin and pyriproxyfen, has resulted in population outbreaks of this scale. This is because these insecticides, while very effective in controlling scale, are also toxic to the Vedalia beetle. It appears that the problem occurs in citrus groves adjacent to those treated with IGRs, as spray drift kills off the predatory insects (Grafton-Cardwell 2001, USDA 2001a).

California red scale can also be controlled by a natural enemy, a parasitic wasp, *Aphytis melinus*. It is mass-reared and released by growers throughout the state. While this natural enemy is not affected by IGRs, it is sensitive to dust that covers leaves and fruit, and so it is not always completely effective (USDA 2001a). Hence, growers in areas affected by both scale species - virtually all in the San Joaquin Valley region - must also apply insecticides to achieve adequate control. High rates of carbaryl are used in this region (upto 16 lb active ingredient (ai)/acre), so as to achieve adequate penetration of and coverage of foliage; high rates also appear more effective on adult cushion scale females (Grafton-Cardwell, personal communication). However, actual use of the maximum allowed 16 lb ai/acre rate appears to be rare. In 2001,California Department of Pesticide Regulation (CDPR) data indicate that the modal (most frequently used) application rate of carbaryl in oranges, the

majority of which is grown in the San Joaquin valley (USDA 2001a), was **12** lb ai/acre, though the data do not specify what insect was targeted.

Carbaryl sprays aimed at red scale are typically timed for May through July when crawlers are the most vulnerable life stage (Grafton-Cardwell et al. 2002). Carbaryl used for cushion scale is most often applied in early spring (March through April) so as to most affect adult females (Grafton-Cardwell, personal communication). Almost all applications are foliar sprays applied by air blast sprayers, though rarely aerial application is also made. Worker activities likely to coincide with these carbaryl applications are irrigation and scouting, which can occur multiple times within a week , and hand harvesting, which occurs according to the mandated 5 day pre-harvest interval (PHI). Pruning also can occur at the time cottony cushion scale treatments are made (Grafton-Cardwell, personal communication). Carbaryl was applied once on average in California oranges and grapefruit in 2001 (NASS 2002). Expert comments also corroborated that a single application of carbaryl is typical (Berger, Grafton-Cardwell, personal communication). Growers are usually able to target Fuller rose beetle, an important export market pest, simultaneously with carbaryl intended for scale (Grafton-Cardwell, personal communication). Virtually all carbaryl applications in California citrus are by ground equipment (airblast sprayers). CDPR data indicate that in 2000, only about 10 % of all applications were by air.

Alternatives to carbaryl

In addition to the natural control exerted by the Vedalia beetle and *Aphytis* wasps, the organophosphates methidathion and malathion, and the IGRs buprofezin and pyriproxyfen, are currently efficacious against both scale species. However, at least 40 % of the citrus acreage in the San Joaquin Valley harbors populations of both scale that are resistant to organophosphates and carbamates, which increases the importance of rotating chemistries to reduce the spread of resistance (Grafton-Cardwell et al. 2002, Grafton-Cardwell, personal communication). In addition, as described earlier, use of the IGRs can increase cushion scale infestations. Thus, in the San Joaquin valley in particular, the importance of carbaryl as a management tool for scale is greatly increased as compared to other areas. About 80 % of California oranges are grown in this region (USDA 2001a).

For most of the insects rarely targeted by carbaryl, BEAD believes effective alternatives include: chlorpyrifos, cyfluthrin, methidathion, malathion, methomyl, *Bt*, spinosad, and cryolite. A notable exception is the Fuller rose beetle, for which cryolite is the only effective alternative. This raises the probability of resistance developing in the long term without carbaryl as a management tool. However, unlike scale, there have been no reports of resistance to either insecticide in this insect as yet.

Florida

Target Pests

A complex of eight root feeding beetle species are targets of most carbaryl applications in citrus grown in this state. Of these, the *Diaprepes* or Apopka root weevil, *Diaprepes abbreviatus*, is considered the most critical pest. This beetle, introduced from the Caribbean, was first detected in the state in Apopka in 1964, and has slowly been spreading and increasing in population since (Futch and McCoy 1993). Isolated populations also exist in Texas citrus (Knapp et al. 2001).

All root weevils can seriously damage citrus roots when feeding as larvae, but *Diaprepes* is particularly destructive because its feeding appears to foster the entry of *Phytophthora palmivora*, a fungus which causes "foot rot" in the roots (Knapp et al. 2001). Although damage by all weevils is most severe in young trees, the combination of feeding damage and foot rot due to this fungus can affect even mature citrus, and even overwhelms otherwise fungus resistant varieties (Knapp et al. 2001). Adult weevils also feed on citrus foliage, but do not cause economic levels of damage. However, carbaryl application targets the adults in an attempt to suppress egg laying (USDA 2001b). These applications are foliar sprays made to affect weevils feeding on leaves (McCoy et al. 2002).

Insects other than these beetles that are also occasionally targeted by carbaryl applications in Florida include orangedog caterpillars, katydids, grasshoppers, crickets and scale. These insects are relatively rare economic problems, however (USDA 2001b).

Carbaryl applications targeting *Diaprepes* weevil use rates of 4 - 8 lb ai/acre (McCoy et al. 2002). However, BEAD believes that **4** lb ai/acre is an effective minimum dose of carbaryl for *Diaprepes* weevil, since most growers used this rate or less in 2001, and it is the minimum rate recommended by the Florida extension service (Doane's proprietary data, McCoy et al. 2002). Growers rarely, if ever, appear to use the maximal 10 lb ai/acre application rate that is allowed by an existing special local needs label for Florida citrus (Doane's proprietary data, Howe, personal communication). An average of 1.5 applications was made in Florida citrus in 2001 (NASS 2002). Florida extension service literature recommends a maximum of two applications per season for *Diaprepes* weevil (Knapp et al. 2001). It is also noteworthy that carbaryl use is not recommended at temperatures above 94 F (McCoy et al. 2003). However, Florida extension literature also advises growers to time foliar insecticide applications to coincide with peak adult emergence. For *Diaprepes* weevil, two peaks occur, one in late August to mid-October, and another from April to mid-June (McCoy et al. 2002).

From this, BEAD infers that carbaryl use intended for weevil control is optimally timed to occur in the usually cooler period of April - June. Carbaryl applications are thus likely to occur when workers need to enter fields to irrigate, scout, or harvest. Harvesting in Florida is most often done mechanically, though some hand harvest does also occur (USDA 2001b). Harvesting is typically done on a weekly basis, as in California. However, irrigation activities (primarily checking and repairing equipment) and scouting for pests must often be carried out more than once a week throughout the season. As in California, most carbaryl applications are by ground airblast sprayers (Aerts, Howe, personal communication).

Alternatives to carbaryl

For those insects rarely targeted by carbaryl in Florida, BEAD believes effective alternatives currently exist. These include *Bt*, chlorpyrifos, and azinphos-methyl (Stansley et al. 2002). For *Diaprepes* weevil, efficacious alternatives currently registered include fenpropathrin, a synthetic pyrethroid, and diflubenzuron, an IGR. Bifenthrin, also a pyrethroid, is also effective but is only available until 2004 under a section 18 registration (McCoy et al. 2002). Cultural controls, such as weed control to eliminate alternate hosts, adequate soil drainage and irrigation, along with the use entomophagous nematodes active against weevil larvae, can also provide some control (McCoy et al. 2002), though BEAD believes they are not often adequate without some use of synthetic insecticides against adults.

Pest Management Impacts of Extending the REI for Carbaryl

Any extension of the REI should allow irrigation equipment checks and scouting for pests to continue to be performed, as per WPS standards. Based on the available crop production literature and comments from crop experts and growers, BEAD believes that these critically important activities occur more than once on a weekly basis, and may sometimes occur on a daily basis. Growers could also continue to prune trees, another important worker activity that can overlap with carbaryl use, at intervals of upto 7 days. Given these caveats, BEAD believes an REI extension of up to 5 days would allow growers to continue to use carbaryl against the target pests described above without significant yield losses, since it would allow the other crucial worker activity of hand harvesting to occur appropriately.

If the REI is extended beyond 5 days, BEAD believes that the use of carbaryl would effectively be lost, because citrus trees flower continuously, and so harvest can occur during much of the year across all growing regions. Thus, harvest is likely to coincide frequently with carbaryl application. The majority of citrus in California is hand harvested (USDA 2001a); in Florida, some oranges and much of the lime and specialty citrus are also hand harvested (USDA 2001b). If carbaryl use is lost, growers would increase the use of the remaining control alternatives. **In California**, BEAD believes that most growers would initially try to control scale (their critically important targets) with one additional application of methidathion, since it has greater residual activity than malathion (Grafton-Cardwell, personal communication). This would allow adequate protection against scale **in the short term**. The IGR alternatives are severely limited in practical terms because (1) applications are only allowed once per year, and growers already incorporate these chemicals into their spray program (2) one of them - buprofezin - does not have an international maximum residue limit (MRL) established, hence preventing exportation of the harvest, and (3) these chemicals can decimate populations of a natural control agent of the cushion scale, the Vedalia beetle (Ewart, Grafton-Cardwell, personal communication).

Therefore, BEAD does not believe these chemicals will be viewed as adequate substitutes for

carbaryl. However, California red scale typically has four generations/year, cottony cushion scale has 3 generations/year (Grafton-Cardwell et al. 2002**)**, and resistance to organophosphates has been reported in California (Grafton-Cardwell 2001). Based on this information, BEAD believes that the potential for resistance to organophosphate insecticides is high, and that it is possible that methidathion will lose its effectiveness in the range of three years or more. When this occurs, **in the long term**, barring the introduction of as yet undiscovered control measures, BEAD believes that growers will often suffer significant losses - up to 48 % of fruit downgraded from the fresh market to processing (as described earlier).

In Florida, BEAD believes that, in **the short term**, growers could effectively substitute one application each of fenpropathrin and diflubenzuron for the typical two applications of carbaryl currently used (two applications is arbitrarily assumed as typical, since the average number of applications in 2001 was 1.5, as cited earlier in this document). However, the absence of carbaryl (a carbamate chemistry) means that these insecticides represent the two remaining different chemistries faced by the insect. Therefore, **in the long term** (beyond 3 years), BEAD believes that these insecticides are likely to also lose their effectiveness as *Diaprepes* weevil management tools. *Diaprepes* weevil has a longer generation time than the scales that California growers face (Futch and McCoy 1993), so BEAD acknowledges that resistance may develop more slowly in the weevil. BEAD has been unable to estimate at what rate such resistance would develop, since there appears to be no research on this aspect. Further, BEAD has found no clear estimates of yield losses attributable to uncontrolled *Diaprepes* weevil damage. However, given the eventually irreversible damage to the root system caused by the combination of weevil feeding and fungal infection, it seems likely that in this long term time frame, uncontrolled weevil damage would result in the need to replace trees, if not entire citrus groves.

Economic Impacts of Extending the REI of Carbaryl on Citrus in California and Florida

Economic impacts are estimated for orange growers in California and orange and lime growers in Florida. The available data suggest that carbaryl is not used extensively on other citrus grown in these states.

California

As discussed above, if the REI for carbaryl is extended beyond 5 days in California, orange growers would likely choose not to use carbaryl and would apply methidathion instead for the control of scale. As a result, **in the short term**, growers would face higher per acre pest control costs due to the higher cost of methidathion relative to carbaryl, but would not suffer any yield or quality losses in the harvested fruit. Under this scenario, per acre operating costs would only increase $37 (or 1%) due to the higher cost of methidathion. However, due to the relatively small per acre net returns for California orange growers, this 1% change in per acre operating costs results in a 43% decline in per acre net

returns for orange growers. (See Table 1 in Appendix).

In the long term, due to the expectation of increasing scale resistence to methidathion, California orange growers are likely to face increased losses in the quality of the fruit harvested from the damage caused by scale. As much as 48% of the fruit currently harvested for the fresh market could suffer quality damage leading to a change in market destination from fresh to processing. Due to the low price received for processing oranges in California relative to the fresh market price, per acre gross and net returns are expected to decline significantly to where orange production may no longer be feasible. Per acre gross revenues could decline as much as 46%, while per acre net returns could decline as much 9 times from the baseline, resulting in negative per acre returns (despite declines in fresh fruit packing costs; see Table 2 in Appendix).

On a state level, impacts are expected to be less significant because less than 4% of the California orange acreage is treated with carbaryl. In the short run, losses could amount to more than $261,000 (7060 acres treated x $37 loss per acre), which is less than 0.1% of the 2001-2002 total value of California orange production. In the long run, losses could amount to $5.5 million (7060 acres treated x $777.50 loss per acre), which is 1% of the 2001-2002 total value of California orange production.

Florida

In Florida, the impact of extending the REI for carbaryl on citrus beyond 5 days is expected to result in an increase in the cost of production for both orange and lime growers in the short run. Growers are expected to discontinue to the use of carbaryl (two applications per season) for the control of weevils and switch to a combination of fenpropathrin and diflubenzuron (1 application each). Because these two compounds are more expensive than carbaryl, per acre operating costs are estimated to increase by 2% for both Florida orange and lime growers. Since no yield or quality losses are expected, per acre net returns would be expected to decline only by the $20 increase in per acre operating costs, resulting in a 2% decline in per acre net returns for orange growers and a 1% decline in per acre net returns for lime growers. (See Tables 3 and 4 in Appendix).

In the long run, it is expected that, similar to California, resistance in the target pest (weevil in this case) may develop to the alternatives suggested for carbaryl. We do not have an estimate of the potential impacts of this resistance, so it has not been quantified. However, the impacts could be significant, due to the decline in fruit yield and the eventual need to replace infested trees.

On the state level, an estimated 8% of the Florida orange acreage is treated with carbaryl, and as much as 50% of the Florida lime acreage is treated. In the short run, losses could amount to a total of $968,000 (48,400 acres treated x $20 loss per acre) for Florida orange growers, which is 0.1% of the 2001-2002 total value of orange production in Florida. While for Florida lime growers, in the short run, losses could amount to $8,000 (400 acres treated x $20 loss per acre), which is 0.5% of the

2001-2002 total value of lime production in Florida.

Conclusions

BEAD believes that carbaryl plays an important role in the management of scale insects in California, and a somewhat less critical role in managing other insects in California and the *Diaprepes* weevil in Florida. When considering the extension of REIs as a mitigation scenario, BEAD assumes that irrigation equipment checks and scouting for pests can continue to be carried out adequately regardless of REI length, as long as they meet the WPS exemption requirements. These activities are carried out more than once in a weekly period and are crucial for pest management. Pruning, another critical worker activity coinciding with carbaryl applications in citrus, could continue to occur with an REI as long as 7 days. However, if the REI is extended beyond 5 days, BEAD believes that both California and Florida growers will be unable to use carbaryl for any of the target insects, since this would prevent hand harvest from being carried out adequately. This would result in an effective loss of carbaryl use for much of the year, since citrus trees can flower and fruit continuously. If this happens, **in the short term** (up to approximately 3 years at least), BEAD believes that the critical target pests can continue to be managed with the remaining chemical and non-chemical control alternatives. After this estimated time frame, however, resistance development, particularly in scale, is likely to render these alternatives useless. When this happens, California citrus growers may lose as much as 46% in per acre gross revenues due to fruit quality losses. BEAD is unable to make a similar assessment of losses to Florida growers, but believes that it is likely to be significant.

Sources

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Appendix

Table 1. Per Acre Gross returns, Production Costs and Net Returns to Orange Growers in California in the Short Term (1-3 Years) in the Base and Alternative Scenarios

	Base Scenario: carbaryl	Alternative: methidathion	% Change Between Base and Alternative Scenarios
total production (boxes/acre)	300	300	0%
fresh	240	240	
processed	60	60	
price ($/box)			
fresh	13.00	13.00	0%
processed	0.30	0.30	
total gross revenues ($/acre)	3138.00	3138.00	0%
fresh	3120.00	3120.00	
processed	18.00	18.00	
insecticide costs ($/acre)			
carbaryl [1]	18.00		
methidathion [2]		55.00	205%
other insecticides	102.00	102.00	0%
other operating costs ($/acre)	2932.00	2932.00	0%
cultural costs	1429.00	1429.00	
harvest costs	1503.00	1503.00	
total operating costs ($/acre)	3052.00	3089.00	1%
net cash returns ($/acre)	86.00	49.00	-43%

Sources: USDA/NASS, Citrus Fruits 2002 Summary; University of California Cooperative Extension, Sample Costs to Establish an Orange Orchard and Produce Oranges: San Joaquin Valley, 2002.

Footnotes:

1. The estimated cost of carbaryl is $18 per acre. The assessment assumes an average of 1 application of carbaryl per acre per season to control scale.

2. The estimated cost of methidathion is $55 per acre. The assessment assumes one application of methidathion to replace the one application of carbaryl.

Table 2. Per Acre Gross returns, Production Costs and Net Returns to Orange Growers in California in the Long Term (More than 3 Years) in the Base and Alternative Scenarios

	Base Scenario: carbaryl	Alternative: methidathion	% Change Between Base and Alternative Scenarios
total production (boxes/acre) [1]	300	300	0%
fresh	240	125	-48%
processed	60	175	192%
price ($/box)			
fresh	13.00	13.00	0%
processed	0.30	0.30	
total gross revenues ($/acre)	3138.00	1677.50	-46%
fresh	3120.00	1625.00	
processed	18.00	52.50	
insecticide costs ($/acre)			
carbaryl [2]	18.00		
methidathion [3]		55.00	205%
other insecticides	102.00	102.00	
other operating costs ($/acre) [4]	2932.00	2212.00	-25%
cultural costs	1429.00	1429.00	0%
harvest costs	1503.00	783.00	-48%
total operating costs ($/acre)	3052.00	2369.00	-22%
net cash returns ($/acre)	86.00	-691.50	904%

Sources: USDA/NASS, Citrus Fruits 2002 Summary; University of California Cooperative Extension, Sample Costs to Establish an Orange Orchard and Produce Oranges: San Joaquin Valley, 2002.

Footnotes:

[1] In the long run (more than 2 years) due to the development of methidathion resistance in scales, production is expected to suffer losses in fruit quality, resulting in 48% of the previously harvested fresh fruit sold in the processing market.

[2] The estimated cost of carbaryl is $18 per acre. The assessment assumes an average of 1 application of carbaryl per acre per season to control scale.

[3] The estimated cost of methidathion is $55 per acre. The assessment assumes one application of methidathion to replace the one applications of carbaryl.

[4] Harvest costs drop significantly with the shift in end use market from fresh to processed. This is due to decline in the cost to pack the fresh fruit into cartons or boxes.

Table 3. Per Acre Gross returns, Production Costs and Net Returns to Orange Growers in Florida in the Base and Alternative Scenarios

	Base Scenario: carbaryl	Alternative: diflubenzuron/ fenpropathrin	% Change Between Base and Alternative Scenarios
total production (boxes/acre)	390	390	0%
fresh	20	22	
processed	370	370	
price ($/box)			0%
fresh	6.70	6.70	
processed	5.15	5.15	
total gross revenues ($/acre)	2039.50	2039.50	0%
fresh	134.00	134.00	
processed	1905.50	1905.50	
insecticide costs ($/acre)			
carbaryl [1]	36.00		
diflubenzuron/fenpropathrin [2]		56.00	55%
other insecticides	146.00	146.00	
other operating costs ($/acre)	728.00	728.00	0%
total operating costs ($/acre)	910.00	930.00	2%
net cash returns ($/acre)	1129.50	1109.50	-2%

Source: USDA/NASS, Citrus Fruits 2002 Summary; University of Florida, 1999-2000 Comparative Citrus Budgets.

Footnotes:

1. The estimated cost of carbaryl is $18 per acre. The assessment assumes an average of 2 application of carbaryl per acre per season to control scale.

2. The estimated cost of diflubenzuron and fenpropathrin is $36 and $20 per acre, respectively. The assessment assumes one application of each chemical to replace the two applications of carbaryl.

Table 4. Per Acre Gross returns, Production Costs and Net Returns to Lime Growers in California in the Base and Alternative Scenarios

	Base Scenario: carbaryl	Alternative: diflubenzuron/ fenpropathrin	% Change Between Base and Alternative Scenarios
total production (boxes/acre) fresh processed	200 170 30	200 170 30	0%
price ($/box) fresh processed	 13.50 1.75	 13.50 1.75	0%
total gross revenues ($/acre) fresh processed	2347.50 2295.00 52.50	2347.50 2295.00 52.50	0%
insecticide costs ($/acre) carbaryl [1] diflubenzuron/fenpropathrin [2]	 36.00	 56.00	 55%
other insecticides	164.00	164.00	
other operating costs ($/acre)	751.00	751.00	0%
total operating costs ($/acre)	951.00	971.00	2%
net cash returns ($/acre)	1396.50	1376.50	-1%

Source: USDA/NASS, Citrus Fruits 2002 Summary; University of Florida, 1999-2000 Comparative Citrus Budgets.

Footnotes:

1. The estimated cost of carbaryl is $18 per acre. The assessment assumes an average of 2 application of carbaryl per acre per season to control scale.

2. The estimated cost of diflubenzuron and fenpropathrin is $36 and $20 per acre, respectively. The assessment assumes one application of each chemical to replace the two applications of carbaryl.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

MEMORANDUM

SUBJECT: Summary Tables of Carbaryl Benefit Information on Selected Crops

FROM: Donald Atwood, Entomologist
Herbicide and Insecticide Branch
Biological and Economic Analysis Division

THRU: Arnet W. Jones, Chief
Herbicide and Insecticide Branch
Biological and Economic Analysis Division

TO: Neil Anderson/Tony Britten
Reregistration Branch 3
Special Review and Reregistration Division

Summary

Special Review and Reregistration Division (SRRD) has identified several crops as having worker risks above the level of concern. Following discussions with SRRD, BEAD analyzed the impact of two mitigation strategies: extending the re-entry interval (REI) and/or reducing application rates on these crops. The relevant information is presented in the tables that follow.

For the individual crop sites presented in this document, BEAD and SRRD have determined that a full benefits analysis is not needed at this time because the proposed mitigation strategies can be implemented without affecting carbaryl's uses on these crops. For several sites, extending the REI will have little to no impact because there are no activities involving hand labor that typically take place at the same time as carbaryl application. Scouting and irrigation are low contact activities that are often exempted under the Worker Protection Standard. For other sites, reducing the maximum label application rates is sufficient to reduce risk below SRRD's level of concern.

Table 1. Summary of carbaryl benefit information on asparagus.

	Crop	
Author: Nicole Mosz	Date: 05/09/03	
Total acres grown and Total Pounds a.i.	92,000 acres and 36,000 lb	
States Used	MI and WA	
Percent crop treated	34.8 % in EPAQUA 69 % in USDA NASS	
Max label rate / Typical use rate (ai/A/application)	2 lb / 1 lb	
Activities Assessed For Exposure by HED (low, medium, high, and/or very high)	Medium - irrigation and scouting mature plants Very high - hand harvesting	
Current REI / Target REI for Assessed Exposures	Medium High	12 hr / 1 day 12/hr/ 5 day
Current PHI	1 day	
Timing of Application(s)	Pre-harvest (spears) and Post-harvest (fern)	
Formulation(s)	WP, S, XLR	
Application Method(s)	aerial, ground, and chemigation	
Critical Pest Targets	asparagus beetle	
Alternative Insecticide(s)	permethrin, methomyl, malathion pyrethrins, spinosad, dimethoate, chlorpyrifos	
Yield loss assessed (range)	N/A	
Economic Impact	N/A	
Profit Impact?	N/A	
Proposed mitigation and anticipated effect	Rate reduction to 1 lb ai/a/appliction would reduce the proposed REI for high exposure activity from 5 day to 1 day. Experts indicate they are willing to cut the application rate in order to maintain the 1 day PHI.	

In 2000, carbaryl was applied to 90% of the Michigan asparagus acreage and 48% of the asparagus acreage in New Jersey. In 1998 carbaryl was applied to 35% of the Washington asparagus acreage (8).

The asparagus beetle is fairly mobile and the adult beetles insert their eggs into the spears. Carbaryl is used to prevent the beetle from laying eggs on the spears. There is a zero tolerance for asparagus beetle eggs on asparagus in Michigan (5). Carbaryl is labeled at a rate of 2 lb ai/acre for pre-harvest applications, and up to 4 lb ai/acre post-harvest application for ferns. In 2000, average use in Michigan was 0.68 lb ai/acre (8).

Asparagus grows very quickly and must be harvested frequently. Harvesting of asparagus spears generally begins in mid-January in the western U.S. and in early spring in the mid-west and east coast areas, and continues through June. Virtually all harvesting is done by hand, on a repetitive basis, every one to five days during the early part of each growing season. In Michigan, the harvest interval is 1 to 5 days, but about 2 days is normal. In early spring, when it is cool, harvesting every 5 days may be sufficient but as it grows warmer, harvesting needs to be more frequent. In Washington, asparagus is harvested daily but carbaryl is not applied to asparagus during harvest. This harvesting activity lasts one to two months, depending on the size and productivity of fields. After harvest, remaining spears are allowed to grow out into ferns (vegetative growth), during which little to no human presence is required in fields (1,2,3).

The proposed mitigation would require growers to either extend the REI to 5 days or reduce the rate to 1 lb ai/acre. As stated above, growers often must harvest asparagus daily, making an REI of 5 days not feasible. Growers can get effective control of the asparagus beetle at lower rates, as low as 1 lb ai/acre, and consider a label rate reduction at harvest a feasible mitigation option (3,7). In New Jersey, growers may use higher rates (i.e, 1.5 to 2 lb ai/acre) depending on pest pressure. However, the recommended rate is 1 lb ai/acre (9, 10).

In Michigan, the other pesticides are limited as follows. Spinosad is only registered to control the asparagus beetle post harvest on ferns. Dimethoate has a PHI of 180 days, so it is not a replacement for the pre-harvest use of carbaryl. Chlorpyrifos is limited to 1 pre-harvest application so it would not be able to directly replace carbaryl if multiple applications are needed. Pyrethroids are most effective on larvae, which are treated during ferning. Adults must be controlled during harvest. Chlorpyrifos is limited to one application during harvest, which is not adequate if multiple applications are needed. Methomyl has an REI of 48 hours which can be too long for harvest. Malathion is registered for use but is not effective (3, 4, 5).

References

1 Eskelson, S., A. Schreiber, S. E. Crawford, and R. J. Folwell. 1997. Biological and Economic Assessment of the Impact of Pesticide Use on Asparagus. Washington State University Publication No.MISCO193.

2 USDA Crop Profile for Asparagus in California, Feb. 2000.

3 Bishop, Beth, Vegetable Entomologist, Michigan State University. Personal communication with Nicole Mosz, April 2003.

4 USDA Crop Profile for Asparagus in Michigan.

5 A Strategic Plan for the Michigan Asparagus Industry, March 15 - 16, 2000. Web address: http://pestdata.ncsu.edu/pmsp/pdf/miasparagus.pdf

6 USDA Agricultural Statistics, 2001.

7 Alan Schreiber, Washington Asparagus Commission. Personal communication with Don Atwood, April 2003.

8 USDA NASS Agricultural Chemical Use Database. Web address: http://www.pestmanagement.info/nass/

9 Ghidiu , Gerry, Specialist in Vegetable Entomology, Rutgers Cooperative Extension. Personal communication with Nicole Mosz, May 2003.

10 USDA Crop Profile for Asparagus in New Jersey.

Table 2. Summary of carbaryl benefit information on canteloupe.

	Crop	
Author: Nikhil Mallampalli	Date: 05/09/03	
Total acres grown and Total Pounds a.i.	92,500 acres and 6,000 lbs	
States Used	GA, TX, MI	
Percent crop treated	5 % nationally, 18 % in GA, 8 % in TX	
Max label rate / Typical use rate (ai/A/application)	2 lb / 1 lb	
Activities Assessed For Exposure by HED (low, medium, high, and/or very high)	Medium - Irrigation, scouting, hand weeding High - hand harvesting	
Current REI / Target REI for Assessed Exposures	Medium High	12 hr / 4 day 12 hr / 7 day
Current PHI	3 day	
Timing of Application(s)	at plant, post-emergence, late season (near harvest)	
Formulation(s)	WSP, bait	
Application Method(s)	ground and aerial	
Critical Pest Targets	At plant/post-emergence - soil insects (cutworms, darkling ground beetles, and cucumber beetle larvae) . Nearer harvest - cucumber beetles, field crickets, blueberry maggot	
Alternative Insecticide(s)	For beetles: imidacloprid, thiamethoxam, diazinon, methomyl, esfenvalerate. For other insects, except crickets: diazinon, methomyl, permethrin. For crickets: naled.	
Yield loss assessed (range)	N/A	
Economic Impact	N/A	
Profit Impact?	N/A	
Proposed mitigation and anticipated effect	Rate reduction to 1 lb ai/A/applications would decrease high and medium activity REI's to 3 and 1 day, respectively. If REI is extended to anything beyond 3 days, use will probably be prohibited at any time except at-plant, since hand weeding and harvesting can occur twice a week. In such a case significant yield losses could occur.	

References

Godfrey, L.D., R. L. Coviello, C. G. Summers, J. J. Stapleton, M. Murray, and E. T. Natwick. 2000. UC IPM Pest Management Guidelines: Cucurbits. University of California, Davis, CA.
USDA NASS. 2000. Agricultural Chemical Usage: Vegetable Summary.
USDA. 1999. Crop Profile for Melons in California. Available at http://www.pmcenters.org/CropProfiles/index.cfm
USDA. 2003. Pest Management Strategic Plan for Cantaloupe, Honeydew, and Mixed-Melon Production in California. Available at: http://pestdata.ncsu.edu/pmsp/pdf/CAMelon.pdf
Personal communication via e-mail from:
Mr. John LeBoeuf. Research Coordinator, California Melon Research Board. Fresno, CA.
Mr. Rodney Holloway, Vegetable Extension specialist, Texas A&M University, College station, TX.

Table 3. Summary of carbaryl benefit information on cranberries.

	Crop	
Authors: Bill Chism and Steve Smearman	**Date:** May 16, 2003	
Total acres grown and Total Lb. a.i.	35,114 acres and 21,000 lb.	
States Used	WI, MA (95%)	
Percent crop treated	10 to 21% in QUA 35.7% from Cranberry Pest Mgt Strategy Plan	
Max. label rate / Typical use rate (lb. ai/acre / applic.)	2.0 lb. (up to 5 times/yr) 2.1 lb. (once/yr) typical from QUA 1.6 to 3.2 lb./yr typical from Cranberry Institute data	
Activities Assessed For Exposure by HED (low, medium, or high)	2 days Medium Exposure - scouting, training, tying 10 days High - hand harvest, thinning, pruning	
Current REI / Target REI for Assessed Exposures	Medium High	12 hr / 2 day 12 hr / 10 day
Current PHI	7 days	
Timing of Application	**Primary application** May to mid June on larvae	
Formulation(s)	Flowable, Water Sol. Pouch, Suspension (no G)	
Application Method(s)	air, chemigation, or ground	
Critical Pest Targets	**Primarily use** is on blackheaded fireworm **Minor use** for cutworms, cranberry fruitworm, flea beetles, and gypsy moth	
Alternative Insecticide(s)	blackheaded fireworm alternatives: acephate, Bt, or pyrethroids gypsy moth alternatives: acephate, tebufenozide, or Bt	
Yield loss assessed (range)	Not determined	
Economic Impact	Not determined	
Profit Impact?	Not determined	
Proposed mitigation and anticipated effect	Blackheaded fireworm requires the 2.0 lb. rate and growers could tolerate a 2 day REI. Carbaryl is used early season so hand weeding and scouting are the activities of concern. Cranberries are machine harvested.	

Target Pests

Carbaryl is primarily used control the blackheaded fire worm (*Rhopobota naevana*). Over 20% of cranberry growers list the blackheaded fireworm as their number one pest. Alternatives to carbaryl are acephate, Bt, or pyrethroids. Previously azinphos-methyl, chlorpyriphos, and diazinon were available for use on this pest.

REFERENCES:

Cranberry Pest Management Strategic Plan, 2002 available at http://www.nepmc.org/cranberry/pmsp2002/

General U.S. Cranberry Data and Organophosphate Use, 1996. Report submitted to EPA August 1996. Jere Downing, Cranberry Institute.

Commodity-wide Cranberry IPM Assessment and Pest Information Transfer - Final Report by Don Weber, and Anne Averill, 1996.

Available at http://www.pesp.org/1996/cranbery96-final.htm

Filename: Carbaryl Cranberries Benefits table.wpd

Table 4. Summary of carbaryl benefit information on cucumber (fresh).

	Crop	
Author: Don Atwood	Date: 05/09/03	
Total acres grown and Total Pounds a.i.	270,400 acres and 5,200 lb	
States Used	FL, GA, MI, NJ, NY, NC, OR, TX	
Percent crop treated	12.9 % in EPA QUA 5.5 % in USDA NASS	
Max label rate / Typical use rate (ai/A/application)	2 lb / 1 lb	
Activities Assessed For Exposure by HED (low, medium, high, and/or very high)	Medium: Irrigation, scouting, weeding mature plants High: hand harvesting, thinning, turning	
Current REI / Target REI for Assessed Exposures	Medium High	12 hr / 4 day 12/hr/ 7 day
Current PHI	3 day	
Timing of Application(s)	At plant, Post-emergence, bloom, late seasonfoliar	
Formulation(s)	Bait or wettable powder (WSP) as a foliar spray	
Application Method(s)	aerial and ground	
Critical Pest Targets	Striped, spotted, and orange cucumber beetle, pickleworm, flea beetles, leaf hopper, pumpkin caterpillar	
Alternative Insecticide(s)	methomyl, esfenvalerate, carbofuran (at plant), endosulfan, azinphos-methyl, permethrin Pipeline: imidacloprid	
Yield loss assessed (range)	N/A	
Economic Impact	N/A	
Profit Impact?	N/A	
Proposed mitigation and anticipated effect	Rate reduction to 1 lb ai/A/applications would decrease high and medium activity REI's to 3 and 1 day, respectively. If REI is extended to anything beyond 3 days, use will probably be prohibited at any time except at-plant, since hand weeding and harvesting can occur twice a week. In such a case significant yield losses could occur.	

REFERENCES:

1. Agricultural Chemical Usage 2000 Vegetable Summary. 2001. USDA NASS
2. US EPA QUA for carbaryl. 2002
3. Crop Profile for Cucumbers (Fresh Market) in Maryland. 2000. USDA
4. Crop Profile for Cucumbers (Fresh Market) in Michigan. 1999. USDA
5. Crop Profile for Cucumbers in North Carolina. 1999. USDA
6. Crop Profile for Cucumbers in New York. 1999. USDA
7. Crop Profile for Cucumbers (Fresh Market) in Ohio. 1998. USDA
8. Crop Profile for Cucumbers in Oregon. 2000. USDA
9. Crop Profile for Cucumbers in Palau, Micronesia. 2000. USDA

Table 5. Summary of carbaryl benefit information on fresh market tomatoes.

	Crop	
Author: Don Atwood	Date: 05/09/03	
Total acres grown and Total Pounds a.i.	120,570 bearing acres and 4,600 lb	
States Used	CA and FL	
Percent crop treated	2 % in NASS 12 % in QUA	
Max label rate / Typical use rate (ai/A/application)	2 lb / 1.5 lb	
Activities Assessed For Exposure by HED (low, medium, high, and/or very high)	2 day High Exposure - hand harvesting, pruning, staking, tying	
Current REI / Target REI for Assessed Exposures	High	12 hr / 2 day
Current PHI	3 day	
Timing of Application(s)	foliar	
Formulation(s)	Liquid and Bait	
Application Method(s)	aerial, ground, chemigation, and bait	
Critical Pest Targets	cutworm and flea beetles	
Alternative Insecticide(s)	azinphos-methyl, esfenvalerate, methomyl	
Yield loss assessed (range)	N/A	
Economic Impact	N/A	
Profit Impact?	N/A	
Proposed mitigation and anticipated effect	High exposure activities do occur for fresh market tomato production. Due to daily harvest activity associated with fresh tomato production, BEAD concludes that a rate reduction is advisable to maintain the current REI. Reduction in application rate from the 2 lb labeled maximum to the typical use of 1.5 lb would provide an acceptable REI of day 0 (MOE = 98).	

REFERENCES:
1. Agricultural Chemical Usage 2000 Vegetable Survey. 2001. USDA/NASS.
2. US EPA QUA for carbaryl. 2002
3. Crop Profile for Tomatoes (Processing) in California. 1999. USDA
4. Crop Profile for Tomatoes (Fresh) in California. 2000. USDA
5. Crop Profile for Tomatoes in Florida. 1999. USDA

Table 6. Summary of carbaryl benefit information on honeydew melon.

	Crop	
Author: Nikhil Mallampalli	Date: 05/09/03	
Total acres grown and Total Pounds a.i.	28,600 acres and 23,000 lb	
States Used	AZ, CA	
Percent crop treated	10.7 % in EPA QUA 37 % in USDA NASS	
Max label rate / Typical use rate (ai/A/application)	2 lb / 1 lb	
Activities Assessed For Exposure by HED (low, medium, high, and/or very high)	Medium - Irrigation, scouting, hand weeding mature plants High - hand harvesting	
Current REI / Target REI for Assessed Exposures	Medium High	12 hr / 4 day 12 hr / 7 day
Current PHI	3 day	
Timing of Application(s)	at plant, post-emergence, late season (near harvest)	
Formulation(s)	WSP, bait	
Application Method(s)	ground and aerial	
Critical Pest Targets	At plant/post-emergence - soil insects (cutworms, darkling ground beetles, and cucumber beetle larvae) . Nearer harvest - cucumber beetles, field crickets	
Alternative Insecticide(s)	For beetles: imidacloprid, thiamethoxam, diazinon, methomyl, esfenvalerate. For other insects, except crickets: diazinon, methomyl, permethrin. For crickets: naled.	
Yield loss assessed (range)	N/A	
Economic Impact	N/A	
Profit Impact?	N/A	
Proposed mitigation and anticipated effect	Rate reduction to 1 lb ai/A/applications would decrease high and medium activity REI's to 3 and 1 day, respectively. If REI is extended to anything beyond 3 days, use will probably be prohibited at any time except at-plant, since hand weeding and harvesting can occur twice a week. In such a case significant yield losses could occur.	

References:
Godfrey, L.D., R. L. Coviello, C. G. Summers, J. J. Stapleton, M. Murray, and E. T. Natwick. 2000. UC IPM Pest Management Guidelines: Cucurbits. University of California, Davis, CA.
USDA NASS. 2000. Agricultural Chemical Usage: Vegetable Summary
USDA. 1999. Crop Profile for Melons in California. Available at http://www.pmcenters.org/CropProfiles/index.cfm
USDA. 2003. Pest Management Strategic Plan for Cantaloupe, Honeydew, and Mixed-Melon Production in California. Available at: http://pestdata.ncsu.edu/pmsp/pdf/CAMelon.pdf
Personal communication via e-mail from:
Mr. John LeBoeuf. Research Coordinator, California Melon Research Board. Fresno, CA.
Mr. Rodney Holloway, Vegetable Extension specialist, Texas A&M University, College station, TX.

Table 7. Summary of carbaryl benefit information on lowbush blueberries.

	Crop	
Author: Nikhil Mallampalli	Date: 05/09/03	
Total acres grown and Total Pounds a.i.	30,000 bearing acres and 0 lbs in 1997[1], "very low" in 2002[2]	
States Used	ME	
Percent crop treated	N/A	
Max label rate / Typical use rate (ai/A/application)	7.5 lb / 5.6 lb	
Activities Assessed For Exposure by HED (low, medium, high, and/or very high)	High - harvesting, hand pruning, pinching, training	
Current REI / Target REI for Assessed Exposures	High	12 hr / 4 day
Current PHI	1 day	
Timing of Application(s)	Late season (up to 7 days pre-harvest)	
Formulation(s)	WSP	
Application Method(s)	aerial	
Critical Pest Targets	blueberry maggot	
Alternative Insecticide(s)	Methomyl, Phosmet, Azinphos-methyl, Diazinon.	
Yield loss assessed (range)	N/A	
Economic Impact	N/A	
Profit Impact?	N/A	
Proposed mitigation and anticipated effect	Since even the target REI for high contact activities is well below the current PHI, it should allow for hand harvest and carbaryl use (if it occurs at all) to continue in this crop. Other activities listed above are also not impacted by the target REIs. Thus, BEAD believes that no further assessment is needed since no significant impacts on crop production are likely to occur.	

1. Dill, J.F, F.A. Drummond, and C.S. Stubbs. 1998. Pesticide Use on Blueberry: A Survey. Penn State Contract No. USDA-TPSU-UM-0051-1300. Univ. ME, Orono, ME.

2. Personal communication via e-mail from Dr. D. Yarborough, University of Maine.

Table 8. Summary of carbaryl benefit information on okra.

	Crop	
Author: Don Atwood	Date: 05/09/03	
Total acres grown and Total Pounds a.i.	3,200 bearing acres and 5.800 lb	
States Used	AL, FL, GA, TX	
Percent crop treated	33.3 % in EPA QUA 30 % in NASS	
Max label rate / Typical use rate (ai/A/application)	2 lb / 1.5 lb	
Activities Assessed For Exposure by HED (low, medium, high, and/or very high)	High Exposure - hand harvesting, pruning, staking, tying	
Current REI / Target REI for Assessed Exposures	High	12 hr / 2 day
Current PHI	3 day	
Timing of Application(s)	Pre-harvest and post-harvest	
Formulation(s)	Liquid	
Application Method(s)	ground and chemigation	
Critical Pest Targets	Corn earworm, stink bug, grasshopper	
Alternative Insecticide(s)	Bacillus thuringiensis subspecies kurstaki, azadirachtin, pyrethrins, kaolin	
Yield loss assessed (range)	N/A	
Economic Impact	N/A	
Profit Impact?	N/A	
Proposed mitigation and anticipated effect	High exposure activities do occur in okra production. Growers should be able to work around the assessed 2 day REI. However, reduction of the labeled maximum use rate (2 lb) to the typical rate (1.5 lb) would decrease the REI to 1 day. Irregardless, harvest would not be impacted as the current PHI for carbaryl exceeds both the assessed and mitigated REI. A full benefit assessment by BEAD is not required.	

REFERENCES:
1. Agricultural Chemical Usage 2000 Vegetable Summary. 2001. USDA NASS
2. US EPA QUA for carbaryl. 2002.

Table 9. Summary of carbaryl benefit information on olives.

	Crop	
Author: Colwell Cook	Date: 05/09/03	
Total acres grown and Total Pounds a.i.	30,000 acres and 11,000 lb	
States Used	CA	
Percent crop treated	6.7 % in EPA QUA 6.3 % in NASS	
Max label rate / Typical use rate (ai/A/application)	7.5 lb / 5.6 lb	
Activities Assessed For Exposure by HED (low, medium, high, and/or very high)	High Exposure - hand-harvesting, pruning, thinning	
Current REI / Target REI for Assessed Exposures	High	12 hr / 15 day
Current PHI	14 day	
Timing of Application(s)	foliar (June, July, and August)	
Formulation(s)	Liquid	
Application Method(s)	ground	
Critical Pest Targets	crawlers of black scale insects	
Alternative Insecticide(s)	none in-season, methidathion post-harvest	
Yield loss assessed (range)	N/A	
Economic Impact	N/A	
Profit Impact?	N/A	
Proposed mitigation and anticipated effect	Farm Advisors think that the rate could go to 5 lb ai/A, but have no data to indicate efficacy at any lower rate. A reduction in rate of application to 5 lb ai/A would reduce the REI from the proposed 14 days to 11 days. However, due to the limited activities and the 14 day PHI, rate reduction is probably not necessary for this crop.	

Use of carbaryl on olives is highly variable. It targets the crawler stage of black scales, which is the primary insect pest. Scales are usually managed by proper pruning to have an open canopy during the summer. Air flow and high temperatures usually are enough to keep populations of scales low. If the canopy closes, or if it is a cooler than normal summer the insects will exceed threshold and require an insecticide application. The only registered chemical for in-season use is carbaryl. It is applied with oil. Most growers apply carbaryl only once every 4-5 years.

There is little high exposure activity in the olives during timing of application. The activities would be scouting, irrigation (primarily drip or micro-sprinkler), or monitoring olive fly traps. These traps are under the drip line of the trees and subsequently little exposure to leaves.

Farm Advisors think that the rate could go to 5 lbs ai/A, but have no data to indicate efficacy at any lower rate.

REFERENCES:

1. US EPA QUA for carbaryl. 2002
2. Agricultural Statistics 2001. 2002. USDA NASS

3. Crop Profile for Olives in California. May 1999. USDA
4. Connell, Joseph H. Farm Advisor. Personal communication May 1, 2003.
5. Krueger, William H. Farm Advisor. Personal communication May 1, 2003.

Table 10. Summary of carbaryl benefit information on pecans.

	Crop	
Author: Nicole Mosz	Date: 05/09/03	
Total acres grown and Total Pounds a.i.	519,954 acres (TX 32%, GA 25%, and OK 16%) [2] 338.5 million lbs (GA 32%, TX 22%, and NM 18%) [2]	
States Used	Southern U.S. (AL, AR, FL, GA, LA, MS, OK and TX)	
Percent crop treated	15.5 % in QUA 18 % in NASS	
Max label rate / Typical use rate (ai/A/application)	5 lb / 2.5 lb	
Activities Assessed For Exposure by HED (low, medium, high, and/or very high)	High Exposure - harvesting/poling, pruning, thinning	
Current REI / Target REI for Assessed Exposures	High	12 hr / 11 day
Current PHI	14 day	
Timing of Application(s)	late summer, early fall	
Formulation(s)	Liquid	
Application Method(s)	aerial and ground	
Critical Pest Targets	pecan weevil and pecan casebearer	
Alternative Insecticide(s)	weevil and nut casebearer: cypermethrin, esfenvalerate, chlorpyrifos, zeta-cypermethrin, phosmet additional for pecan nut casebearer: malathion, chlorpyrifos, tebufenozide, Bt, endosulfan, spinosad	
Yield loss assessed (range)	N/A	
Economic Impact	N/A	
Profit Impact?	N/A	
Proposed mitigation and anticipated effect	BEAD expects minimal impacts from extending the REI	

[1] Sources: Harvested acreage - USDA/NASS, 1997 Census of Agriculture; Production - USDA/NASS, Noncitrus Fruits and Nuts 2002 Preliminary Summary (1/2003).
[2] Other pecan producing states include: AL, AZ, AR, CA, FL, KS, LA, MS, NC, and SC.
[3] Major carbaryl usage states. There may be other states not listed that use carbaryl, but usage in these states is not known.

Pecan weevil is the primary target pest for carbaryl, but pecan nut casebearer is also consistently targeted with carbaryl. However, the use of carbaryl is not recommended on the pecan nut casebearer because the early season use can cause aphids to become a problem. In addition, there are several alternatives registered for the pecan nut casebearer (1, 2, 4).

Carbaryl is often applied for control of pecan weevils in August through mid-September. In Texas, the first application is made around the third week of August, with a second application possible about 10 days later. Harvest occurs in mid to late fall. The proposed REI should not be a problem for harvesting because the current PHI is greater than the proposed REI. In addition, most pecans are harvested mechanically. The minimal hand harvesting that does occur involves knocking the pecans out of the tree with a pole and then hand picking the nuts off the orchard floor. Often some machinery is used when hand harvesting. Pruning and thinning occur in the spring, well before carbaryl applications for pecan weevil (2, 3).

Orchard floor preparation, which involves mowing and the removal of limbs, with a rake pulled behind a tractor, from the orchard floor must be completed before harvest. However, BEAD does not believe that the proposed REI will be a problem for orchard floor preparation. Also, scouting and a fall pesticide application for black aphid control is critical and growers need to be able to get into the orchard for these activities (1, 2, 3).

Although the extended REI does not appear to conflict with worker activities, the contacts have expressed concern over the length of 11 days (1, 2, 5, 6).

According to EPA data, 90% of the total pecan acres treated with carbaryl per year are at a rate of 2.5 lbs ai or less per application (7). The recommended rate is 2 to 2 ½ lbs ai per acre per application. Based on this information, reducing the labeled rate is an option that should be feasible to the growers (5,6).

References

1. Wood, Bruce, Research Leader, Research Horticulturalist, USDA-ARS Southeastern Fruit and Tree Nut Research Laboratory. Personal communication with Nicole Mosz, April 14, 2003.
2. Ree, Bill, Extension Entomologist, Texas A&M University. Personal communication with Nicole Mosz, April 21, 2003.
3. Pecan Timeline.
4. USDA Crop Profile for Pecans in Texas.
5. Cottrell, Ted, Research Entomologist, USDA-ARS Southeastern Fruit and Tree Nut Research Laboratory. Personal communication with Nicole Mosz, April 22, 2003.
6. Hudson, Will, Extension Entomologist, University of Georgia. Personal communication with Nicole Mosz, April 23, 2003.
7. EPA proprietary data.

Table 10. Summary of carbaryl benefit information on peppers (bell and sweet)

	Crop	
Author: Angel Chiri	Date: 05/09/03	
Total acres grown and Total Pounds a.i.	135,000 acres and 12,000LB	
States Used	CA, FL, KY, LA, MI, IL	
Percent crop treated	5.3 % Bell and 7.7 % Sweet in EPA QUA 4.5 % in USDA NASS	
Max label rate / Typical use rate (ai/A/application)	2 lb / 1 lb	
Activities Assessed For Exposure by HED (low, medium, high, and/or very high)	High - hand harvesting, pruning, typing	
Current REI / Target REI for Assessed Exposures	High	12 hr / 2 day
Current PHI	3 day	
Timing of Application(s)	foliar, variable according to pest	
Formulation(s)	EC, WP	
Application Method(s)	ground	
Critical Pest Targets	flea beetles, wireworm, beet armyworm, green peach aphid, omnivorous leafroller, whiteflies, tomato fruitworm, cutworms, fall armyworms, European corn borer, and yellow-striped armyworm	
Alternative Insecticide(s)	acephate, acetamiprid, cyfluthrin, cypermethrin, endosulfan, esfenvalerate, imidacloprid, indoxacarb, methomyl, permethrin, spinosad, tebufenozide, thiamethoxam	
Yield loss assessed (range)	N/A	
Economic Impact	N/A	
Profit Impact?	N/A	
Proposed mitigation and anticipated effect	No mitigation is proposed as workers can work around a 2 day REI or, when necessary, shift to one of several available alternatives with a shorter PHI.	

REFERENCES:
1. Aerts, Mike, Florida Fruit and Vegetable Association. Personal communication with Angel Chiri, OPP/BEAD, 04/17/03
2. Bessin, Ric, Extension Entomology, University of Kentucky, Personal communication with Angel Chiri, OPP/BEAD, 04/18/03
3. Lewis, Brad, Department of Entomology, New Mexico State University. Personal communication with Angel Chiri, OPP/BEAD, 04/29/03
4. Sorensen, Kenneth A. Department of Entomology, North Carolina State University, Personal communication with Angel Chiri, OPP/BEAD, 04/18/03
5. USDA. 2000. Crop Profile for Bell Peppers in California.
http://pestdata.ncsu.edu/cropprofiles/docs/CAbellpepper.html
6. USDA. 1999. Crop Profile for Peppers (Bell) in Florida.
http://pestdata.ncsu.edu/cropprofiles/docs/FLpeppers-bell.html

Summary of carbaryl benefit information on pistachios

	Crop	
Author: Nicole Mosz	Date: 05/09/03	
Total acres grown and Total Pounds a.i.	78,000 bearing acres and161 million lb	
States Used	California	
Percent crop treated	13.2 % in EPAQUA 13% (1999), 9% (2000), 3 % (2001) in USDA NASS	
Max label rate / Typical use rate (ai/a/application)	2 lb / 1 lb	
Activities Assessed For Exposure by HED (low, medium, high, and/or very high)	harvesting/poling, pruning, thinning	
Current REI / Target REI for Assessed Exposures	High	12/hr/ 11 day
Current PHI	14 day	
Timing of Application(s)	dormant season (scales)	
Formulation(s)	WP, S, XLR	
Application Method(s)	aerial and ground	
Critical Pest Targets	soft scales also used on navel orangeworm (NOW) and leaf-footed plant bug and stink bugs	
Alternative Insecticide(s)	soft scales - none NOW - Bt, permethrin, spinosad, phosmet bugs - permethrin, acephate (plant), pyrethrins (stink)	
Yield loss assessed (range)	N/A	
Economic Impact	N/A	
Profit Impact?	N/A	
Proposed mitigation and anticipated effect	BEAD expects minimal impacts from extending the REI, especially if growers are still able to irrigate.	

The major use is a dormant application of carbaryl with oil, which is used once every few years for control of soft scales, such as frosted scale (*Parthenolecanium pruinosum*) and European fruit lecanium (*P. corni*). There are no other pesticides registered for soft scales. Plant bugs are occasionally treated with carbaryl although permethrin is often used. Pesticides are often applied during the summer, when irrigation and mowing are the main activities occurring in the orchard. Carbaryl is also used as a resistance management tool for navel orangeworm.

Pruning and thinning primarily occurs during the dormant season (although broken limbs or young trees may be pruned in the summer). BEAD does not expect the proposed REI to be a problem for growers because the dormant application of carbaryl is often applied after these activities have occurred. Hand harvesting and poling do not occur on pistachios. Only trees too young for the mechanical shaker may be hand harvested. These trees only comprise a small portion of the acreage. In addition, the proposed REI is shorter than the current PHI, so harvesting should not be a problem for the growers.

Growers must be able to get into the orchards to irrigate. Microsprinkler irrigation occurs every 3 to 5 days in the

summer. This activity involves the irrigator driving along the orchard to make sure the sprinkler heads are working. The irrigator may enter to check or fix the tubing and sprinkler heads. Flood irrigation occurs every 5 to 7 days, with a worker setting up the tubing at one end and monitoring the flow to the other end. There is concern that the growers may not be willing to wear full PPE for early entry as required under the WPS due to the high summer temperatures in the California Central Valley.

References

1. Noncitrus Fruits and Nuts 2002 Preliminary Summary. 2003. USDA NASS
2. California Department of Pesticide Regulation (CDPR), Pesticide Use Reporting Database (1999-2001)
3. Ludwig, Gabriele, Senior Associate, Schramm, Williams & Associates. Personal communication with Nicole Mosz, April 2003.
4. Crop Profile for Pistachios, October 7, 1999.
5. Pistachio Timeline.

Table 11. Summary of carbaryl benefit information on processed tomatoes.

	Crop	
Author: Don Atwood	Date: 05/09/03	
Total acres grown and Total Pounds a.i.	293,500 bearing acres and 18,100 lb	
States Used	CA	
Percent crop treated	12 % in EPA QUA 8 % in NASS	
Max label rate / Typical use rate (ai/A/application)	2 lb / 1 lb	
Activities Assessed For Exposure by HED (low, medium, high, and/or very high)	High Exposure - hand harvesting, pruning, staking, tying	
Current REI / Target REI for Assessed Exposures	High	12 hr / 2 day
Current PHI	3 day	
Timing of Application(s)	foliar	
Formulation(s)	Liquid	
Application Method(s)	aerial, ground, chemigation, and bait	
Critical Pest Targets	cutworm and flea beetles	
Alternative Insecticide(s)	azinphos-methyl, esfenvalerate, methomyl,	
Yield loss assessed (range)	N/A	
Economic Impact	N/A	
Profit Impact?	N/A	
Proposed mitigation and anticipated effect	No high exposure activities occur in processed tomato production. Due to the absence of risk activities, a label change for processed tomatoes is not warranted. Processed tomatoes generally receive less than 2 applications of any insecticide per year. No benefit assessment is required by BEAD.	

REFERENCES:
1. Agricultural Chemical Usage 2000 Vegetable Survey. 2001. USDA/NASS.
2. US EPA QUA for carbaryl. 2002
3. Crop Profile for Tomatoes (Processing) in California. 1999. USDA

Table 12. Summary of carbaryl benefit information on pumpkin.

	Crop	
Author: Nikhil Mallampalli	Date: 05/09/03	
Total acres grown and Total Pounds a.i.	38,700 acres and 11,100 lb	
States Used	IL, MI, NY, OH	
Percent crop treated	18.4 % in EPA QUA 16 % in USDA NASS	
Max label rate / Typical use rate (ai/A/application)	2 lb / 1 lb	
Activities Assessed For Exposure by HED (low, medium, high, and/or very high)	Medium - Irrigation, scouting, hand weeding mature plants High - hand harvesting	
Current REI / Target REI for Assessed Exposures	Medium High	12 hr / 4 day 12 hr / 7 day
Current PHI	3 day	
Timing of Application(s)	post-emergence, bloom, late season (near harvest)	
Formulation(s)	WSP, bait	
Application Method(s)	ground and aerial	
Critical Pest Targets	striped cucumber beetle, squash vine borer, and squash bug	
Alternative Insecticide(s)	permethrin, esfenvalerate, bifenthrin, methomyl, endosulfan, malathion	
Yield loss assessed (range)	N/A	
Economic Impact	N/A	
Profit Impact?	N/A	
Proposed mitigation and anticipated effect	Rate reduction to 1 lb ai/A/applications would decrease high and medium activity REI's to 3 and 1 day, respectively. If REI is extended to anything beyond 3 days, use will probably be prohibited at any time except at-plant, since hand weeding and harvesting can occur twice a week. In such a case significant yield losses could occur.	

References:

Godfrey, L.D., R. L. Coviello, C. G. Summers, J. J. Stapleton, M. Murray, and E. T. Natwick. 2000. UC IPM Pest Management Guidelines: Cucurbits. University of California, Davis, CA.
USDA NASS. 2000. Agricultural Chemical Usage: Vegetable Summary.
Personal communication via e-mail from:
Mr. Rodney Holloway, Vegetable Extension specialist, Texas A&M University, College station, TX.

Table 13. Summary of carbaryl benefit information on squash.

	Crop	
Author: Nikhil Mallampalli	Date: 05/09/03	
Total acres grown and Total Pounds a.i.	57,100 acres and 12,800 lb	
States Used	MI, GA, TX, SC, TN, OH, OR, NY, NC, NJ	
Percent crop treated	12.9 % in QUA 12 % nationally; 36 % in MI; 73 % in TN (states with highest lbs used)	
Max label rate / Typical use rate (ai/A/application)	2 lb / 1 lb	
Activities Assessed For Exposure by HED (low, medium, high, and/or very high)	Medium: Irrigation, scouting, hand weeding High: hand harvesting	
Current REI / Target REI for Assessed Exposures	Medium High	12 hr / 4 day 12/hr/ 7 day
Current PHI	3 day	
Timing of Application(s)	Post-emergence, bloom, foliar	
Formulation(s)	Bait or wettable powder (WSP) as a foliar spray	
Application Method(s)	aerial and ground	
Critical Pest Targets	Striped cucumber beetle, squash vine borer, squash bug	
Alternative Insecticide(s)	permethrin, esfenvalerate, bifenthrin, methomyl, endosulfan, malathion	
Yield loss assessed (range)	N/A	
Economic Impact	N/A	
Profit Impact?	N/A	
Proposed mitigation and anticipated effect	Rate reduction to 1 lb ai/A/applications would decrease high and medium activity REI's to 3 and 1 day, respectively. If REI is extended to anything beyond 3 days, use will probably be prohibited at any time except at-plant, since hand weeding and harvesting can occur twice a week. In such a case significant yield losses could occur.	

REFERENCES

Godfrey, L.D., R. L. Coviello, C. G. Summers, J. J. Stapleton, M. Murray, and E. T. Natwick. 2000. UC IPM Pest Management Guidelines: Cucurbits. University of California, Davis, CA.
USDA NASS. 2000. Agricultural Chemical Usage: Vegetable Summary.
Personal communication via e-mail from:
Mr. Rodney Holloway, Vegetable Extension specialist, Texas A&M University, College station, TX.

Table 14. Summary of carbaryl benefit information on strawberries.

	Crop	
Author: Angel Chiri	Date: 05/09/03	
Total acres grown and Total Pounds a.i.	52,000 acres and 9,000 lb	
States Used	CA, FL, NC, PA	
Percent crop treated	17.3% EPA QUA 16% USDA NASS	
Max label rate / Typical use rate (ai/A/application)	2 lb / 1 lb	
Activities Assessed For Exposure by HED (low, medium, high, and/or very high)	High: hand harvesting, hand pruning, pinching, training	
Current REI / Target REI for Assessed Exposures	High	12 hr / 4 day
Current PHI	7 day	
Timing of Application(s)	foliar	
Formulation(s)	bait, EC, WP	
Application Method(s)	aerial and ground	
Critical Pest Targets	clipper or strawberry bud weevil, strawberry fruitworm, leafhoppers, spittlebugs, tarnished plant bug, stink bugs, slugs, root weevils, crickets, grasshoppers, cutworms, European earwig	
Alternative Insecticide(s)	*Bacillus thuringiensis*, bifenthrin, chlorpyrifos, diazinon, endosulfan, fenpropathrin, malathion, metaldehyde, methomyl, methoxychlor	
Yield loss assessed (range)	N/A	
Economic Impact	N/A	
Profit Impact?	N/A	
Proposed mitigation and anticipated effect	Extending the REI from 12 hours to 4 days will not significantly affect strawberry production practices. Hand harvesting already prohibited until day 7 by current PHI.	

Only hand harvesting, which in California occurs every two days, would be affected by a four day REI, were it not already covered by the established 7 day PHI. The other high risk activities assessed for exposure (hand pruning, pinching, training) do not apply to strawberry production. In California, carbaryl is applied primarily as bait at the base of the plant to control cutworms and earwigs, at the average rate of 1.6 lb a.i./acre. There are alternatives available for other uses.

REFERENCES:

1. Aerts, Mike, Florida Fruit and Vegetable Association. Personal communication with Angel Chiri, OPP/BEAD, 04/17/03
2. DeFrancesco, Joe, Department of Entomology, Oregon State University. Personal communication with Angel Chiri, OPP/BEAD, 04/29/03
3. Sorensen, Ken, Department of Entomology, North Carolina State University. Personal communication with Angel Chiri, OPP/BEAD, 04/17/03

4. USDA. 1999. Crop Profile for Strawberries in California.
5. USDA. 2000. Pest Management Strategic Plan for Strawberries in FL, NC, SC, VA.
6. Wells, Jim, California Strawberry Commission, Personal communication with Angel Chiri, OPP/BEAD, 04/24/03

Table 15. Summary of carbaryl benefit information on sweet cherries.

	Crop	
Author: Don Atwood	Date: 05/09/03	
Total acres grown and Total Pounds a.i.	63,400 bearing acres and 55,300 lb	
States Used	CA, MI, OR, WA	
Percent crop treated	31 % in NASS 22.5 % in EPA QUA	
Max label rate / Typical use rate (ai/A/application)	2 lb / 1.5 lb	
Activities Assessed For Exposure by HED (low, medium, high, and/or very high)	High Exposure - thinning Very High Exposure -harvesting, pruning, training, and tying	
Current REI / Target REI for Assessed Exposures	High Very High	12 hr / 1 day 12 hr / 8 day
Current PHI	1 day	
Timing of Application(s)	Pre-harvest and post-harvest	
Formulation(s)	Liquid	
Application Method(s)	aerial and ground	
Critical Pest Targets	Pre-Harvest - Cherry fruit fly, american plum borer, european earwig, eyespotted bud moth, fruittree leafroller, green fruitworm, orange tortrix, peach twig borer, redhumped caterpillar, western tussock moth Post-Harvest - Cherry leafhopper, mountain leafhopper	
Alternative Insecticide(s)	azinphos-methyl (time limited registration), phosmet, spinosad	
Yield loss assessed (range)	N/A	
Economic Impact	N/A	
Profit Impact?	N/A	
Proposed mitigation and anticipated effect	Sweet cherries are not thinned. There is no very high exposure activity. High exposure activities do occur. Experts indicate that they would prefer the current 12 hr REI but could work with the 1 day assessed REI. However, as the calculated MOE on day 0 is 97 with a target of 100, increasing the REI by an additional 12 hours is probably not justified. A full benefit assessment by BEAD is not required.	

REFERENCES:
1. Agricultural Chemical Usage 2001 Fruit Summary. 2002. USDA NASS
2. US EPA QUA for carbaryl. 2002
3. Personal communication with Dr. Mark Whalen. 2003. Michigan State University.
4. Personal communication with Philip Korson II. 2003. Cherry Marketing Institute, Inc.
5. Personal communication with Jim Culbertson. 2003. California Cherry Advisory Board.
6. Personal communication with Dr. Mike Willett. 2003. Northwest Horticultural Council.

7. Crop Profile for Cherries in New York. 2000. USDA.
8. Crop Profile for Cherries (Sweet) in Oregon. 1999. USDA.

Table 16. Summary of carbaryl benefit information on sweet potatoes.

	Crop	
Author: Don Atwood	Date: 05/09/03	
Total acres grown and Total Pounds a.i.	NA	
States Used	LA, MS, NC, TX	
Percent crop treated	not surveyed by NASS 16.92 % in EPA QUA	
Max label rate / Typical use rate (ai/a/application)	2 lb / 1.5 lb	
Activities Assessed For Exposure by HED (low, medium, high, and/or very high)	Medium Exposure - irrigation and scouting High Exposure - hand harvesting	
Current REI / Target REI for Assessed Exposures	Medium High	12 hr / 4 day 12 hr / 7 day
Current PHI	7 day	
Timing of Application(s)	at plant, bed treatment, foliar	
Formulation(s)	Liquid and Bait	
Application Method(s)	aerial, ground, chemigation, and bait	
Critical Pest Targets	cutworm and flea beetles	
Alternative Insecticide(s)	phosmet, methyl parathion, endosulfan	
Yield loss assessed (range)	N/A	
Economic Impact	N/A	
Profit Impact?	N/A	
Proposed mitigation and anticipated effect	High exposure activities do occur for sweet potatoes. However, exposure can be characterized as low as the treated vines are removed prior to digging. Experts indicate that the 4 day REI determined for medium exposure activities is acceptable for this crop.	

REFERENCES:
1. US EPA QUA for carbaryl. 2002
2. Personal conversation with Dr. James Robinson. 2003. Texas Agricultural Extension Service
3. Personal conversation with Dr. Abner Hammond. 2003. Louisiana State Extension Service.

Table 17. Summary of carbaryl benefit information on table beets.

	Crop	
Author: Don Atwood	Date: 05/09/03	
Total acres grown and Total Pounds a.i.	6,400 bearing acres and N/A	
States Used	NY and WI	
Percent crop treated	16.4 % in EPA QUA N/A% in USDA NASS	
Max label rate / Typical use rate (ai/A/application)	2 lb / 1 lb	
Activities Assessed For Exposure by HED (low, medium, high, and/or very high)	Medium - Irrigation and scouting, hand weeding mature plants High - hand harvesting	
Current REI / Target REI for Assessed Exposures	Medium High	12 hr / 4 day 12 hr / 7 day
Current PHI	7 day (root) / 14 day (tops)	
Timing of Application(s)	foliar	
Formulation(s)	liquid and bait	
Application Method(s)	ground and aerial	
Critical Pest Targets	cutworms	
Alternative Insecticide(s)	azadirachtin, Bacillus thuringiensis var kurstaki, and diazinon	
Yield loss assessed (range)	N/A	
Economic Impact	N/A	
Profit Impact?	N/A	
Proposed mitigation and anticipated effect	Rate reduction to 1 lb ai/A/applications would decrease high and medium activity REI's to 3 and 1 day, respectively. Table beet experts indicated that lowering the rate is an acceptable option for this crop. However, due to the extended PHI's (roots and tops) and no reliance on medium exposure activities, the proposed REI's would problably cause no harship. In addition, carbaryl is not used every year but remains important for cutworm control in years in which outbreaks occur.	

REFERENCES:
1. Agricultural Chemical Usage 2000 Vegetable Summary. 2001. USDA NASS
2. US EPA QUA for carbaryl. 2002
3. Personal communication with Dr. J.A. Wyman. 2003. University of Wisconsin.
4. Personal communication with Dr. Arly Mcfall. 2003. Cornel University.

Table 18. Summary of carbaryl benefit information on tart cherries.

	Crop	
Author: Don Atwood	Date: 05/09/03	
Total acres grown and Total Pounds a.i.	29,600 bearing acres and 6,300 lb	
States Used	MI and NY	
Percent crop treated	22.5 % in QUA 9 % in NASS	
Max label rate / Typical use rate (ai/A/application)	7.5 lb / 5.6 lb	
Activities Assessed For Exposure by HED (low, medium, high, and/or very high)	High Exposure - harvesting, pruning, training, tying Very high - thinning	
Current REI / Target REI for Assessed Exposures	High Very High	12 hr / 1 day 12/hr/ 8 day
Current PHI	1 day	
Timing of Application(s)	foliar (Spring) and Post-harvest	
Formulation(s)	Liquid	
Application Method(s)	aerial and ground	
Critical Pest Targets	Cherry fruit fly (zero tolerance), Plum curculio, japanese beetle	
Alternative Insecticide(s)	azinphos-methyl (time limited registration), phosmet, spinosad Pipeline - actara, calypso	
Yield loss assessed (range)	N/A	
Economic Impact	N/A	
Profit Impact?	N/A	
Proposed mitigation and anticipated effect	No very high exposure activity (thinning). No mitigation is proposed for high exposure activities. Growers would accept 1 day REI for high exposure activities but would prefer to maintain the current 12 hr REI.	

Carbaryl use on sweet cherries does not warrant a full benefit assesment by BEAD. There is also no need for mitigation as thinning and hand harvesting do not occur for this crop.

Carbaryl is primarily used to control cherry fruit fly in tart cherry production. Carbaryl has increased in importance for use in tart cherry production due to recent regulations on other OP's. Carbaryl application is essential to provide continuous crop protection following rains which reduce the effectiveness of previous insecticide applications. It is primarily used as a recovery spray for insecticides with long (14 day) re-application intervals. Continuous protection of tart cherries is essential due to the zero tolerance for cherry fruit fly.

REFERENCES:

1. Agricultural Chemical Usage 2001 Fruit Summary. 2002. USDA NASS
2. US EPA QUA for carbaryl. 2002
3. Personal communication with Philip Korson II. Cherry Marketing Institute. 2003
4. Personal communication with Dr. Mark Whalen. Michigan State University. 2003.

5. Crop Profile for Cherries (Tart) in Pennsylvania. 2000. USDA
6. Crop Profile for Cherries in New York. 2000. USDA
7. Tart Cherry Pest Management in the Future: Development of a Strategic Plan. 2000.

Table 19. Summary of carbaryl benefit information on watermelon.

	Crop	
Author: Nikhil Mallampalli	Date: 05/09/03	
Total acres grown and Total Pounds a.i.	150,500 acres and 6,200 lb	
States Used	AL, FL, GA, NC, and TX	
Percent crop treated	8.4 % in EPA QUA 4 % in USDA NASS	
Max label rate / Typical use rate (ai/A/application)	2 lb / 1 lb	
Activities Assessed For Exposure by HED (low, medium, high, and/or very high)	Medium - Irrigation, scouting, hand weeding mature plants High - hand harvesting	
Current REI / Target REI for Assessed Exposures	Medium High	12 hr / 4 day 12 hr / 7 day
Current PHI	3 day	
Timing of Application(s)	at plant, post-emergence, late season (near harvest)	
Formulation(s)	WSP, bait	
Application Method(s)	ground and aerial	
Critical Pest Targets	At plant/post-emergence - soil insects (cutworms, darkling ground beetles, and cucumber beetle larvae). Near harvest - cucumber beetles, field crickets	
Alternative Insecticide(s)	For beetles: imidacloprid, thiamethoxam, diazinon, methomyl, esfenvalerate. For other insects, except crickets: diazinon, methomyl, permethrin. For crickets: naled.	
Yield loss assessed (range)	N/A	
Economic Impact	N/A	
Profit Impact?	N/A	
Proposed mitigation and anticipated effect	Rate reduction to 1 lb ai/A/applications would decrease high and medium activity REI's to 3 and 1 day, respectively. If REI is extended to anything beyond 3 days, use will probably be prohibited at any time except at-plant, since hand weeding and harvesting can occur twice a week. In such a case significant yield losses could occur.	

References:

Godfrey, L.D., R. L. Coviello, C. G. Summers, J. J. Stapleton, M. Murray, and E. T. Natwick. 2000. UC IPM Pest Management Guidelines: Cucurbits. University of California, Davis, CA.
USDA NASS. 2000. Agricultural Chemical Usage: Vegetable Summary.
USDA. 1999. Crop Profile for Watermelons in Texas. Available at http://www.pmcenters.org/CropProfiles/index.cfm
Personal communication via e-mail from:
Mr. Rodney Holloway, Vegetable Extension specialist, Texas A&M University, College station, TX.